# Adaptive Back Sheet Material for Acoustic Liner Applications

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## Abstract

This project involves the development of a piezoelectric material that can be bonded to the back side of a perforate-over-honeycomb acoustic absorptive liner. When actuated, the material will form a compliant back wall of the resonator chamber, which will vary the effective impedance at the liner surface, and thus the resonant frequency. The researchers demonstrated the compliant back wall in Phase I. The objectives in Phase II are: to improve the control authority of the piezo-electric, to incorporate the concept into a Grazing Flow Impedance Tube sample liner, and to refine the mathematical model of the compliant back wall.

The purpose of this research project is to demonstrate the applicability of a newly discovered smart composite material to serve as a compliant back wall for an acoustic liner. Such a compliant back wall allows the liner to respond to changes in the aircraft engine noise spectrum, which is a function of engine speed, by actively modifying the liner impedance. The material being investigated consists of an α-Helical Polypeptide, which has been developed by researchers at the Johns-Hopkins University Applied Physics Laboratory, and has shown promise as an actuator capable of being excited at frequencies in the audible range. Built-up coupons, 2 in. x 2 in., consisting of perforate face sheet, honeycomb, and piezoelectric material back wall, will be evaluated in the Normal Incidence Tube in the Liner Technology Facility at NASA LaRC. The normal incidence impedance will be determined, first with no excitation of the piezo-electric material in order to determine the baseline acoustic impedance. Then, the piezo-electric material will be excited over a range of discrete frequencies and voltages, and the normal incidence impedance will be evaluated. Acoustic wave propagation theory will be used to estimate the change in sound attenuation that can be expected with the variable impedance. Experiments will be developed to identify the physical parameters required to formulate the mathematical model. Tests to date have shown that although excitation of the piezo with a dynamic voltage significantly affects the acoustic response, the current design lacks sufficient control authority to change the impedance significantly. Material compositions and electrode designs that improve the control authority by at least one order of magnitude will be investigated. Once tests of the 2 in x 2 in samples are complete, a coupon of size 2 in. x 24 in. will be fabricated for evaluation in the Grazing Flow Impedance Tube. This liner sample will have a sufficient number of chambers with actuator back walls to allow groups of chambers to be actuated at different frequencies and the feasibility of broadband noise control can be evaluated.